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A NEW DESIGN OF TUNGSTEN-GRAPHITE THERMOCOUPLE

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In many instances, it is convenient to use a tungsten-graphite thermocouple for measuring high temperatures. With a tungsten-graphite thermocouple, the temperature can be varied up to 2,000 degrees. It is comparatively cheap and gives sufficiently accurate readings. Its main drawback is that tungsten is very prone to oxidation at high temperatures, for which reason it is necessary to portect it with an especially impenetrable mounting and place it in a neutral medium. This circumstance is evidently the main cause of its limited use.

At the same time it is possible, given good design, for the tungsten-graphite thermocouple to find wide application under production and laboratory conditions. One should point out the existing design of tungsten-graphite thermocouple suggested by collaborators of Academician M. A. Pavlov, and successfully used by them for short-time determinations of temperature in the mining blast furnaces of the Magnitogorsk and Zaporozhe plants. (I. Z. Kozlovich, Sovetskaya metallurgiya, No 9, 1936). For these measurements, the thermocouple had no protective case and was still capable of measuring the temperature the whole way from the periphery to the axis of the blast furnace.

However, the design of tungsten-graphite thermocouple used in blast furnaces is unsuitable for laboratory conditions in view of its unwieldiness. A brief description of a new design of tungsten-graphite thermocouple is given below.

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The thermocouple consists of a hollow graphite rod. A tungsten wire spiral is located 5 millimeters from the end of this rod. To avoid oxidation of the tungsten, the spiral is sealed with a high-melting material, consisting of finely ground magnesite mixed with refractory clay in the ratio of 4 to 1. The spiral is in close contact with the graphite rod. A protective tube is inserted in the rod, and the free end of the tungsten wire is led out through it.

This combination of working parts permits thermocouples being made from very thin graphite tubes and various thicknesses of tungsten wire. Moreover, it very much simplifies mounting and the avoidance of damage. In view of the considerable brittleness of graphite, we recommend ordering thin tubes from the appropriate factories, or making them from electrodes with a central core. The core is made of a material softer than graphite, and so a hole up to 400 millimeters long can easily be made by hand with a twist or pointed drill. When the opening has been made, the graphite tube is machined on an ordinary lathe. For this purpose it is held in the lathe with a compressible bronze chuck sleeve and brought to the required diameter by plain turning. To avoid fractures, the tube should be machined in separate stages 25 - 30 millimeters long. With an initial thickness of 10 - 12 millimeters, the cut should not exceed 0.3 millimeters. Experience has shown that a graphite tube with an external diameter of 8 millimeters and a 2- to 4-millimeter diameter hole can easily be manufactured by this method.

After calibration, the tungsten-graphite thermocouple was tested by using it to measure temperature in a layer of hot coke subjected to forced draught.

To avoid oxidation of the tungsten and safeguard the thermocouple from mechanical damage due to the coke, it was protected by quartz casings 8 millimeters in internal diameter and 2 millimeters thick. The gaps between the casing and the graphite tube, and between the insert and the tungsten wire were filled up with plasteline. During the experiments in burning solid fuel in an enlarged laboratory installation, the temperature was measured with five tungsten-graphite thermocouples simultaneously.

Numerous experiments showed that a thermocouple of this design can withstand temperature of 1,200 - 1,700 degrees for many hours without damage. We did not observe a single case of damage to the thermocouple which was not preceded by failure of the quartz casing. On this basis, we consider that, given casings and inserts which are gas tight and have a higher melting point than quartz, and a less fusible material for sealing the contact spiral, the proposed design of thermocouple will be able to make prolonged temperature measurements up to 2,000 degrees.

We therefore recommend that tests of our design of tungsten-graphite thermocouple should be performed under other laboratory conditions for measuring high temperatures.

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